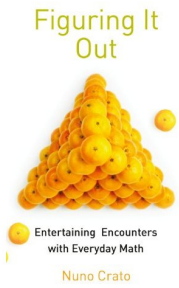
Figuring it out – Entertaining encounters with everyday math, 2010, Springer, ISBN 978-3-642-04832-6, 27.95 € (hbk), 227 pp. by *Nuno Crato*.



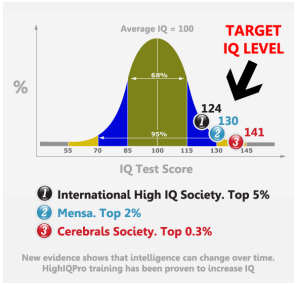
Nuno Crato

Nuno Crato, a former president of the Portuguese Mathematical Society (2004-2010), is a mathematics university professor in Lisbon. He is well known also among Portuguese non-mathematicians as a science writer and he featured regularly on Portuguese radio and television. In 2011 he became the minister of education. Portugal plays a leading role in the European Mathematical Societies when it comes to popularization of mathematics. As an example, you might be interested in watching the six *YouTube* videos that were shown on Portuguese television in a series called *isto é matemática*[1]

In this book Crato has collected 56 mathematical short 'stories', two to five pages long, and organized in six chapters. Each story points to some mathematical aspect of everyday life or relates some mathematical tidbit that everybody can be amused with or fascinated by. The nice thing being that the math itself is not really included. These stories should counter the man in the street's ignorance about mathematics and mathematicians. The point he wants to make is, as we all know, that mathematics is everywhere and that without mathematics, we would still live in a prehistoric society.

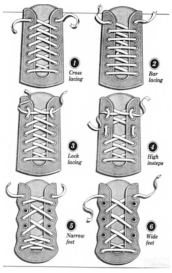
I have seen many books on popularization of mathematics or that connect mathematics to all kinds of art forms, but this book is definitely different. Of course there are some obvious subjects that one will also find at other places, but there are also some items that were also new to me. Let me go through the chapters and mention some of the subjects.

the other lane is faster



IQ increases

necktie knots

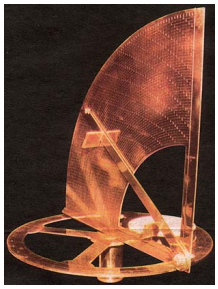


shoe lacing

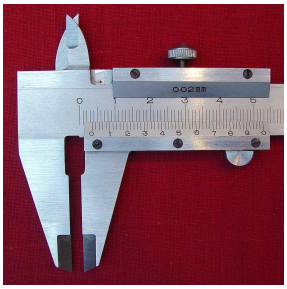
1. Everyday mathematics. This starts with logic SAT problems. E.g., whom to invite to a party, given certain compatibility conditions or other logical constraints. This entails the notions of NP problems. Game theory is illustrated with a cake cutting problem. The cover of the book shows how oranges can be piled up in an efficient way (sphere packing). That this way is optimal was first considered by Thomas Harriot (1560-1621) who discussed it with Johannes Kepler (1571-1630), and it was the subject of one of the first proofs by computer given by Thomas C. Hales in 1998. The result was published in the *Annals of Mathematics* although the computational aspects were not considered to be part of the mathematical proof. Some other topics are · the design of a just voting system · how the average IQ increases over the years · knots in neckties and lacing of shoes · sudokus, and · why it does not pay to keep changing lanes in a traffic jam, even though the other lane seems to be always the faster one.

2. The earth is round. Here we find · GPS and satellites · gear wheels in (mechanical) clocks · the shortest path for a plane to fly from Europe to the USA · the nonius scale and Vernier's

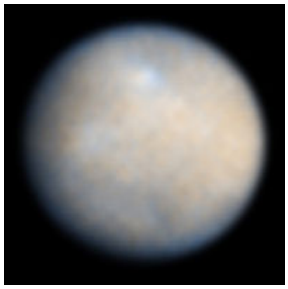
[1] `www.youtube.com/user/istoematematica`



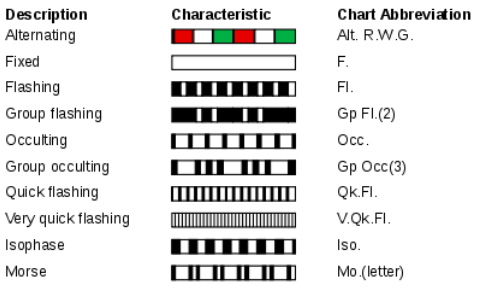
original nonius



nonius Vernier scale

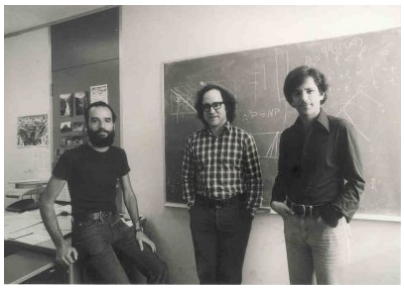


Ceres

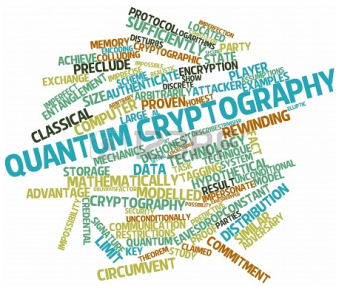


flash patterns

modification · the light characteristics of a lighthouse (these describe the type of flashes it emits, which will allow to identify it). Ceres, a dwarf planet, was discovered by Giuseppe Piazzi (1747-1826), but it seemed to have disappeared and could not be found again, until Carl Friedrich Gauss (1777-1855) at the age of 24 predicted the position. He used his method of least squares to calculate the orbit, and on the basis of these calculations Ceres was rediscovered by Franz von Zach (1754-1832) at only a half degree of angular distance from where Gauss had predicted it.



l.t.r. S, R, and A



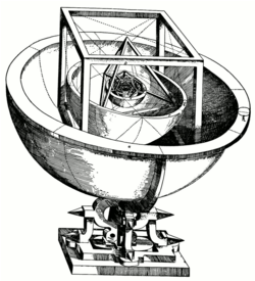
quantum cryptography

Enigma machine

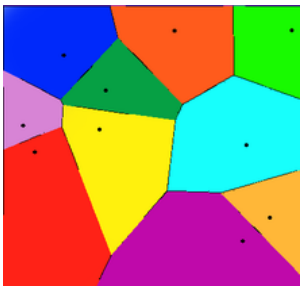
fingerprint

3. Secret affairs. Public key encryption is an obvious choice to fit in here, and also the RSA algorithm of Rivest, Shamir and Adler used to encrypt for example your credit card number when you send it over the Internet. When computers become fast enough to crack the RSA code, new methods like quantum cryptography has to be designed. Two other topics are the German Enigma machine used during WWII to encrypt military messages and the wavelet techniques used by the FBI to compress their database of fingerprints.

Fobonacci spiral



Platonic solids

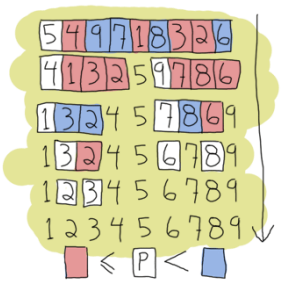


Voronoi diagram

Jackson Pollock

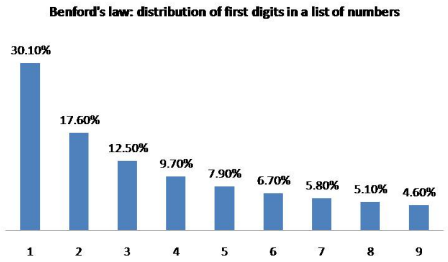
4. Mathematics and art. The items in this section are a bit more predictable. The Vitruvian man is an occasion to discuss pentagrams. Furthermore · Fibonacci numbers, the golden ratio, and paper sizes · the Platonic solids · the Möbius strip and the art of M.C. Escher · the fractal nature of the paintings of Jackson Pollock (1912-1956). Picasso in *Les demoiselles d'Avignon* tried to represent a three dimensional object in a four dimensional space by depicting different viewpoints in the same painting on a two dimensional canvas. Around the same time Henri Poincaré in his *Science et hypothèse* explains how a four dimensional world can be represented in a two-dimensional picture. The placement of observation towers in a forest used by park rangers to detect fires are illustrations of Voronoi diagrams, i.e., an optimal division of the plane depending on a given set

of points. Other topics are frequencies in music but also in the mating process of mosquitos. And finally... the most beautiful of all: $e^{i\pi} = -1$.



quicksort

captcha



Benford's law

5. Mathematical objects. The coherence here is a bit obscure to me, but the topic could be philosophical and sociological aspects of mathematics. It starts with some discussion of why nature seems to be following the rules of mathematics, or is it the other way around? The difference are explained between Platonism (according to which mathematics exists independent of our existence, waiting for us to be discovered) and formalism (considering mathematics as an axiomatic and logical construction, a 'game' of no significance). Variations of the quicksort algorithm leads to stochastic methods like Monte Carlo and Las Vegas type of algorithms, but also to some thoughts about what it really means to be random. What a conjecture is, is illustrated by the Collatz conjecture (which goes with many other names as well). A sequence is constructed as follows. Take an integer n, if it is even, divide it by 2, and otherwise compute $2n + 3$. The conjecture states that the sequence will always end with the number 1. It has been proved to be algorithmically undecidable in 2007. Benford's law says that the a digit $k \in \{1, \ldots, 9\}$ being the first significant digit in a number increases if k is smaller. This has been used to detect tax fraud or falsified budgets of countries. The analysis of (financial) time series revealed the so-called *Noah effect* (the typical abrupt discontinuous changes) and the *Joseph effect* (the long term persistence of trends), biblically inspired terms coined by Mandelbrot. The Turing test which is conceived to distinguish a man from a machine, and hence to define intelligence, is reflected in the *captcha*'s (Completely Automated Public Turing test to tell Computers and Humans Apart) that we have to read and type on websites to identify ourselves as humans. There is also a note on DNA computers and on π-day.

6. Out of this world. This collects some paradoxes. Among others, we find items discussing different voting systems (one man, one vote vs. others) that may not always result in the democratic objective that is strived for. The equality $0.999\ldots = 1$ and calculus with ∞ may give unexpected results for the layman. Furthermore there is Bertrand's paradox (after Joseph Bertrand) and the paradox of William Newcomb. In the latter there are 2 boxes, a transparent and a black one. Predictor P puts 1.000 € in the transparent box, and puts either nothing or 1.000.000 € in the black box. Then he calls in B and tells him to freely choose either the black box or both boxes and keep the contents, but he warns B that he can perfectly predict B's choice and foretells that if B chooses both boxes he will get just the 1.000 €, while if B chooses the black box, he will get the 1.000.000 €. Depending on B's reasoning, either choice can be optimal for him. If P predicted he would choose the black box, it is better to choose both and vice versa.

This collection is really a joy to read. The items are short and can be consumed in a short couple of minutes and so reading can be interrupted if needed. This is the literature that should be in the waiting rooms all over the country instead of the glossies and tabloids. People spend there some short time and can be called in at any moment. An excellent moment to read one of the stories. Lacking a cup of tea or coffee, this is a worthy alternative.

Adhemar Bultheel